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# The Tessellattice of Mother-space as a Source and Generator of Matter and Physical Laws

Volodymyr Krasnoholovets

Institute for Basic Research, 90 East Winds Court, Palm Harbor, FL 34683, U.S.A. *E-mail address:* v.kras@yahoo.com

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**Abstract.** Real physical space is derived from a mathematical space constructed as a tessellation lattice of primary balls, or superparticles. Mathematical characteristics, such as distance, surface and volume, generate in the fractal tessellation lattice the basic physical notions (mass, particle, the particle's de Broglie wavelength and so on) and the corresponding fundamental physical laws. Submicroscopic mechanics developed in the tessellattice easily results in the conventional quantum mechanical formalism at a larger atomic scale and Newton's gravitational law at a macroscopic scale.

## 1. Introduction

Although Poincaré (1905a) was the first to write the relativistic transformation law for charge density and velocity of motion, Einstein's (1905) special relativity article received wide recognition perhaps due to his introduction of a radically new abstract approach to fundamentals, which then culminated in his famous theory of general relativity (Einstein, 1916). Due to his great predictions, which were verified experimentally, abstract theoretical concepts took root in the minds of a majority of physicists. Einstein's approach resembled rather a generalized description that descended to particulars through a series of postulated axioms. His general relativity considers how matter and geometry, constructed in the empty space, coexist and influence each other, though matter is not an intrinsic property of space.

Einstein's thoughts regarding an aether were expressed in his well-known lecture (Einstein, 1920). He noted since space was endowed with physical qualities, an aether existed. Then he mentioned, according to general relativity, space without an aether is unthinkable (light would not propagate, there would not any space-time intervals in the physical sense, etc.). Nevertheless, Einstein

stressed that this aether might not be thought of as endowed with quality characteristic of a ponderable medium, consisting of parts that might be tracked through time. However, the basic issue remained: Why could the aether not be associated with a substrate? This was never clarified by Einstein completely.

At the same time, a hypothesis about the existence of an aether as a material substrate responsible for electromagnetic wave propagation has been tested by many researchers (Miller, 1933, Essen, 1955, Azjukowski, 1993). A new optical method of the first order was proposed and implemented by Galaev (2002) for measurements of the aether-drift velocity and kinematic viscosity of aether. Galaev's results correlate well with the results of other researchers quoted above. Observability, reproducibility and repeatability of aether drift effects have been conducted in various geographical conditions with help of different methods of measurements and in various ranges of electromagnetic waves. Overall, the above-mentioned researches strongly supported the idea the aether is a substrate responsible for propagation of electromagnetic waves. These studies shed light on negative results of measurements of aethereal wind by Michelson and Morley: Their tool had too low a sensitivity.

Other researchers have made a demonstration of direct interaction of matter with a subquantum medium. In particular, an influence of a new "strange" physical field on specimens was fixed by Baurov (2002), Benford (2002) and Urutskoev et al. (2002). Similar effects are described by Shipov (1997), though the changes in samples examined were associated with the so-called "torsion radiation" introduced by Shipov as a primary field that allegedly was dominating over a vague physical vacuum long before its creation. One more incomprehensible phenomenon is the Kozyrev effect (Kozyrev and Nasonov, 1978) at which a bolometer centrally located in the focal point of a telescope recodes a signal from a star much earlier than the light signal hitting the focal point.

Let us look now briefly at Poincaré's studies. His researches were also highly abstract especially those dealing with mathematics and mathematical physics. Nevertheless, in physics applications, he tried to bear on natural laws as close as possible. Granted, Poincaré (1905b, 1906) believed any new success in science was an additional support of determinism. In his works, he tried to start just from details that then should disclose the problem studied as a whole. Poincaré (1905b) strongly supported the idea of an aether, considering motion of a particle as accompanied by an aether perturbation. Such idea, perturbation of the aether by a moving object, dominated over leading mathematicians and physicists up to beginning of the 20th century.

Therefore, his idea deserves credit (if a kind of an aether in fact exists). Poincaré considered particles as peculiar points in the aether, though he did not develop further ideas on its construction nor principles of the motion of material objects in it. Experimental facts were not abundant at that time as well as theoretical elaborations of condensed matter physics, which would help one to look at a possible theory of aether in more detail. Besides, mathematical methods of description of space were also rather in an embryonic state at be-

ginning of the 20th century despite the fact it was Poincaré who proposed and developed new concepts and methods of the investigation of space as such. At that time, facts were not numerous as now, which then did not allow Poincaré to consolidate ideas on space and aether in a unified generalized concept of real space.

However, today when practically all the facts are already available, we may try to look at a possibility of unification of mathematical and physical ideas regarding incorporation of an aether with space in one unified object of comprehensive study.

## 2. The constitution of space

Many researchers are involved in the search for a theory of everything (TOE). However, how about a “theory of something”? The problem was studied by Bounias (2000) on the basis of pure mathematical principles. He firmly believed the ultimate theory could be some mathematical principle.

Following upon Bounias (2000), Bounias and Krasnoholovets (2002, 2003), we can explore the problem of the constitution of space in terms of topology, set theory and fractal geometry. Evidently according to set theory, only the empty set (noted  $\emptyset$ ) can represent nearly nothing. If  $F$  is a part of  $E$ , then the remaining part of  $E$  that does not contain  $F$  is the complementary of  $F$  in  $E$ , which is noted as  $\mathbb{C}_E(F)$ . The empty set  $\emptyset$  is contained in any set  $E$ , i.e.  $\mathbb{C}_E(E) = \{\emptyset, E\}$ , then  $\mathbb{C}_E(E) = \emptyset$ ; this last result together with  $\mathbb{C}_E(\emptyset) = E$  are known as the first law of Morgan. All this allowed Bounias to conclude the complement of the empty set is the empty set:  $\mathbb{C}_{\emptyset}(\emptyset) = \emptyset$ . Following von Neumann, Bounias considered an ordered set,  $\{\{\{\emptyset, \{\emptyset\}\}, \{\emptyset, \{\emptyset, \{\emptyset\}\}\}, \text{and so on}\}$ . Looking at the set, one can count its members:  $\emptyset =$  zero,  $\{\emptyset\}$ ,  $\{\emptyset\} =$  one, and so on. This is the empty set as long as it consists of empty members and parts. However, on the other hand, it has the same numbers of members as the set of natural integers,  $N = \{0, 1, 2, \dots, n\}$ . Although it is properly that the reality is not reduced to the enumeration, the empty sets give rise to mathematical space that in turns brings about physical spaces. So *something* can exist emerging from emptiness.

The empty set is contained in itself, hence it is a non-well-founded set, or hyperset, or empty hyperset. Any parts of the empty hyperset are identical, either a big part ( $\emptyset$ ) or the singleton  $\{\emptyset\}$ ; the reunion of empty sets is also the same:  $\emptyset \cup (\emptyset) \cup \{\emptyset\} \cup \{\emptyset, \{\emptyset\}\} \cup \dots = \emptyset$ . This is the major characteristic of a fractal structure, which means the self-similarity at all scales (in physical terms, from the elementary sub atomic level to cosmic sizes). One empty set  $\emptyset$  can be subdivided into two others; two empty sets generate something  $(\emptyset) \cup (\emptyset)$  that is larger than the initial element. Consequently, the coefficient of similarity is  $\rho \in [1/2, 1]$ . In other words,  $\rho$  realizes the fragmentation when it falls within the interval  $]1/2, 1[$  and the union when  $\rho$  with the interval  $]0, 1/2]$  yields  $]0, 1[$ . The coefficient of similarity allows one to estimate

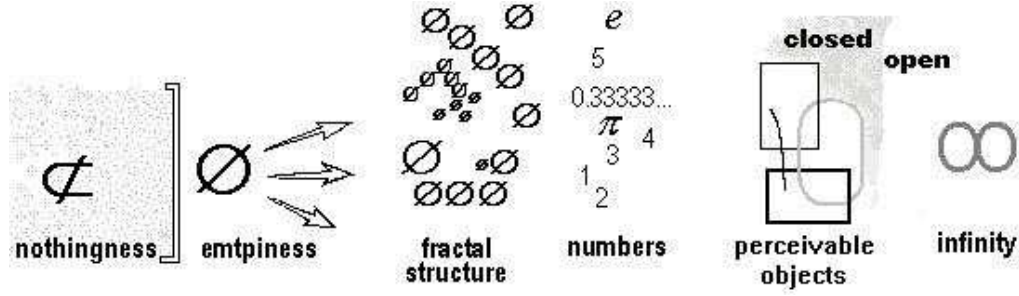


Figure 1: Range of things, from non-existence to something empty whose structure gives rise to something non-empty and up to infinity (from Bounias and Krasnoholovets, 2002).

the fractal dimension of the empty hyperset, which owing to the interval  $]0, 1[$  becomes a fuzzy dimension.

Time can be called “nothing”, because it is a singleton that does not have parts (in other case it will be in contradiction to the definition of time as such). The nothingness singleton ( $\epsilon$ ) is absolute unique. It is the greatest lower boundary of everything that exists; this is the infimum of existence, Figure 1.

4-D mathematical spaces have parts in common with 3-D spaces, which gives 3-D closed structures; then there are parts with 2-D, 1-D and dimension zero (points). General topology indicates the origin of time, which should be treated as an assembly of sections  $S_i$  of open sets. Indeed, fractality of space generates fuzzy dimensions (Bounias and Krasnoholovets, 2003a) and hence a part in common of a couple of open sets  $W_m$  and  $W_n$  with different dimensions  $m$  and  $n$  also accumulates points of the open space. If  $m > n$ , then those points that belong to  $W_m$  and would not belong to the section of the given sets cannot be included in a  $x$ -D object. Bounias and Krasnoholovets (2002) exemplified this in the following way: “You cannot put a pot into a sheet without changing the shape of the 2-D sheet into a 3-D packet. Only a 2-D slice of the pot could be a part of a sheet.” Therefore infinitely many slices, i.e. a new subset of sections with dimensionality from 0 to 3, ensure the raw universe in its timeless form.

Thus a physical space one can provide by closed intersections (timeless Poincaré sections) of abstract mathematical spaces. What would happen with these sections  $S_i$  that all belong to an embedding 4-space? A series of sections  $S_i, S_{i+1}, S_{i+2}$ , etc. resembles the successive images of a movie and only nothing does not move. Because of that, difference of distribution of objects within two corresponding sections will mean a detectable increment of time. Therefore, time will emerge from order relations holding on these sections.

Two successive slices show a characteristic of mathematical objects from one to the next section. In other words, this is a mapping. The first section produces some  $x$  that then becomes  $f(x)$  on the next one. The mapping between nearest sections can be treated in the framework of an indicatrix function  $1(x)$  and

Uryson's theorem. By definition,  $1(x)$  for any  $x$  states yields  $1(x) = 0$  if  $x$  has one property and  $1(x) = 1$  if  $x$  has an alternative property. A combination of  $f(x)$  with  $1(f(x))$  makes a demonstration that the result is depend on whether the variable  $x$  belonging to one part of the frame in  $S_i$  or will belong to the same part in  $S_{i+1}$ . The complete function is a composition of the variables with their distribution. In other words, the function has the structure of a moment; it was called a 'moment of junction'  $MJ$  by Bounias (2000), Bounias and Krasnoholovets (2003b). The function  $MJ$  describes the smallest increment of space (only one point is not at the same topological position for  $MJ$  to permit the change). Furthermore, such a fine change of  $MJ$  defines also an increment in time - the minimal change. Since there is no any thickness between two sections  $S_i$  and  $S_{i+1}$ , the moment of junction  $MJ$  rigorously describes a differential element of space, which is also a differential element of time. And this validates differential geometry for the description of the Universe.

### 3. Measure, distance, metric and objects

The concept of measure usually involves such particular features as the existence of mappings and the indexation of collections of subsets on natural integers. Classically, a measure is a comparison of the measured object with some unit taken as a standard. The "unit used as a standard", this is the part played by a gauge ( $J$ ).

A measure involves respective mappings on spaces that must be provided with the rules  $\cap$ ,  $\cup$  and  $\complement$ . According to Bonaly and Bounias (1996), in spaces of the  $\mathbb{R}^n$  type, tessellation by balls are involved which again demands a distance to be available for the measure of diameters of intervals. The intervals can be replaced by topological balls and therefore the evaluation of their diameter still needs an appropriate general definition of a distance. More comprehensive determinations of measure, distance, metric and objects, which involve topology, set theory and fractal geometry have been done by Bounias and Krasnoholovets (2003a, 2004).

In physics, a ruler is called a metric. As a rule, in mathematics spaces including topological spaces were treated as not endowed with a metric and the properties of metric spaces have not been the same as those of non-metric spaces. However, in 1994 Bounias (see e.g. Bonaly and Bounias, (1996)) could show that there was not exist a non-metric topological space!

Indeed, union and intersection allow the introduction of the symmetric difference between two sets  $A_i$  and  $A_j$

$$\Delta(A_i, A_j) = \complement_{\cup \{A_i\}} \cup_{i \neq j} (A_i \cap A_j) \quad (1)$$

i.e. the complementary of the intersection of these sets in their union. The symmetric difference satisfies the following properties:  $\Delta(A_i, A_j) = 0$  if  $A_i = A_j$ ,  $\Delta(A_i, A_j) = \Delta(A_j, A_i)$  and  $\Delta(A_i, A_j)$  is contained in the union of

$\Delta(A_i, A_j)$  and  $\Delta(A_j, A_k)$ . This means that it is a true distance and it can also be extended to the distance of three, four and etc. sets in one, namely,  $\Delta(A_i, A_j, A_k, A_l, \dots)$ . Since the definition of a topology implies the definition such a set distance, every topological space is endowed with this set metric. The norm of the set metric is  $\|A\| = \Delta(\emptyset, A)$ . Therefore, all topological spaces are metric spaces,  $\Delta$ -metric spaces, and they are measurable.

Let us look now at the remaining part, i.e. the intersection of the sets. If they are of unequal dimensions, this intersection will be closed, i.e. the intersection in a closed space is closed,  $\cup_{i \neq j} (A_i \cap A_j)$ , which signifies the availability of physical objects. As distances  $\Delta$  are the complementariness of objects, the system stands as a manifold of open and closed subparts. This procedure subdivides the Universe into two parts: the distances and the objects.

In general, we can imagine the universe as an immense drop containing  $\mathfrak{N}$  balls. Since the measure embraces such notions as length, surface and volume, we may represent  $\ell$  – the loop distance of the universe (i.e. the perimeter that can be measured with a ruler) – through the parameters of those  $\mathfrak{N}$  balls. Indeed, let  $\mathfrak{m}$  be the measure of the balls (length, surface, or volume of dimension  $\delta$  depending on what kind of the characteristics we are interested in). Inside of a universe of dimension  $D$  we have  $\mathfrak{N}$  times  $\mathfrak{m}^\delta$  approximately equal to  $\ell^D$ , so that

$$D \sim (\delta \cdot \log \mathfrak{m} + \log \mathfrak{N}) / \log \ell. \quad (2)$$

Thus if we know component parts of the universe, i.e. can describe sizes and shapes of the topological balls, we will be able to reconstruct the large unknown structure.

#### 4. Tessellation lattice of primary balls

Let us now examine what is space-time in the approach proposed by Bounias and Krasnolovets (2003, 2004). What he proposed initially was the founding element. Namely, it is generally recognized that in mathematics some set does exist. A weaker form can be reduced to the existence of the empty set. If one provides the empty set  $(\emptyset)$  with the combination rules  $(\in, \subset)$  and the property of complementary  $(\complement)$ , a magma can be defined. Those preliminaries allowed Bounias to formulate the following theorem. The magma  $\emptyset^\emptyset = \{\emptyset, \complement\}$  constructed with the empty hyperset and the axiom of availability is a fractal lattice. Writing  $(\emptyset)$  denotes that the magma reflects the set of all self-mappings of  $\emptyset$ . The space constructed with the empty set cells of the magma  $\emptyset^\emptyset$  is a Boolean lattice and this lattice  $\mathfrak{S}(\emptyset)$  is provided with a topology of discrete space, Bounias and Krasnolovets (2003a). A lattice of tessellation balls has been called a “tessel-lattice” and hence the magma of empty hyperset becomes a fractal tessel-lattice.

The introduced lattice of empty sets ensures the existence of a physical-like space. In fact, the consequence of spaces  $(W_m), (W_n), \dots$  formed as parts of the empty set  $\emptyset$  shows the intersections that have non-equal dimensions, which

gives rise to spaces containing all their accumulating points forming closed sets (Bounias and Krasnolovets, 2003a). If morphisms are observed, then this enables the interpretation as a motion-like phenomenon, when one compares the state of a section with the state of mapped section. A space-time-like sequence of Poincaré sections is a non-linear convolution of morphisms (Bounias and Krasnolovets, 2003a). Therefore, our space-time becomes one of the mathematically optimum ones. And time is an emergent parameter indexed on non-linear topological structures guaranteed by discrete sets. In other words, the foundation of the concept of time is the existence of order relations in the sets of functions available in intersect sections.

Thus time is not a primary parameter. And the physical universe has no more beginning: time is just related to ordered perceptions of existence, not to existence itself. The topological space does not require any fundamental difference between reversible and steady-state phenomena, nor between reversible and irreversible process. Rather relation orders simply hold on non-linearity distributed topologies, and from rough to finest topologies.

Such fundamental notions as point, distance and similitude allow the introduction of relative scales in the empty-set lattice, i.e. the tessell-lattice, and therefore space everywhere becomes quantic [26,28]. Indeed, from mapping  $G : N^D \mapsto Q$  of  $(N \times N \times N \times \dots)$  in  $Q$  we can identify a set of rational intervals. In this way, for  $n$  integers in each one of the 2-D space,  $n \times n$ , the pair  $(1, n)$  yields fraction  $1/n$  and the pair  $(1, n-1)$  yields ratio  $1/(n-1)$ . So their distance is the smaller interval, i.e. the difference between these two fractions gives the smaller interval proportional to  $1/n^2$  or more exactly, the interval  $1/(n-1) - 1/n = 1/(n(n-1))$  that denotes a special scale limit depending on the size of the considered space (recall this smaller interval, which is formed by  $n^2$  grains, is constructed from  $\emptyset$ ). In 3-D, we will have interval  $1/n^2(n-1)$ .

Predictable orders of size from  $x = 1$  to  $x = 60$  to be clusters/universes whose objects range from 1 (the Planck scale, the size of an elementary cell of the tessell-lattice), to  $\sim 10^{10}$  elementary cells (roughly comply with quark-like size), to about  $10^{17}$  cells (atomic size), to  $10^{21}$  cells (molecular size), to  $10^{28}$  (human size), to  $10^{40}$  cells (star system size) up to  $10^{56}$  cells (greatest cosmic structures). So, we can see that the universe suggests a quite different organization of matter at different scales.

## 5. Generation of matter

Nowadays quantum and particle physics are considered as most fundamental disciplines. They examine the behavior of quantum systems, such as the interaction between particles in the presence of this or that potential(s), transformations of particles to the other ones, etc. However, fundamental notions quantum physics operates with (mass, wave  $\psi$ -function, wave-particle, de Broglie and Compton wavelengths, spin and so) are out of any comprehension

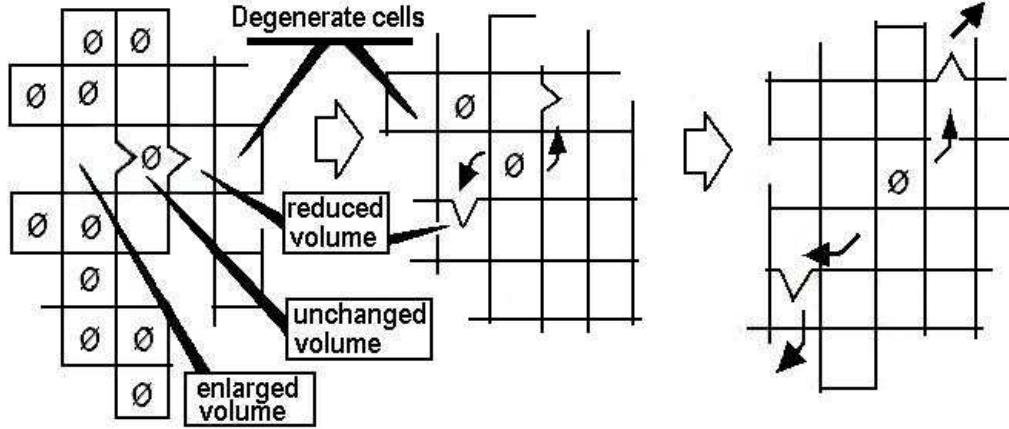


Figure 2: Volumetric fractality of cells as elementary deformations of the tessellattice. These deformations can occur with and without change in the volume of cells. Local deformations that produce reduction of the volume of cells are associated with the local generation of mass. These deformations can migrate in the tessellattice from cell to cell (from Bounias and Krasnoholovets, 2002).

of their nature and origin, because these microscopic parameters a priori are treated as basic, or primordial. Such a viewpoint makes it possible to raise a question about conceptual difficulties of quantum mechanics (Krasnoholovets, 2004). So, are we able to develop deeper first principles that will derive the fundamental notions basing on a sub microscopic concept? And hence the “strangeness” of quantum mechanical behavior of particles will be complete clarified owing to inner determinism that establishes very peculiar links in quantum systems, which are hidden under the crude orthodox quantum formalism. In quantum electrodynamics, neither an electric charge nor a magnetic charge has yet been in physical terms. They are abstract concepts transcribed into observable properties and reflected in modelling equations.

If we wish to provide an insight of the structure of an abstract physical vacuum, we must assume that this substance is rather nothing, instead of being complete empty. But nothing allows the consideration in terms of space, namely, topology, set theory and fractal geometry, which has just been demonstrated in the previous sections.

One of our starting points is the idea that the organization of matter at the microscopic (atomic) level should reproduce some submicroscopic space ordering. This means that the lattice of a crystal should be the reflection of the arrangement of the real physical space. This space can fully be associated with the tessellattice of densely packed balls, or superparticles. And this is the degenerate space (that one may associate with an abstract physical vacuum). Superparticles that constitute founding cells of the tessellattice are stacked without any unfilled place between them, which refers to the nothingness singleton, addressed in the section 2.



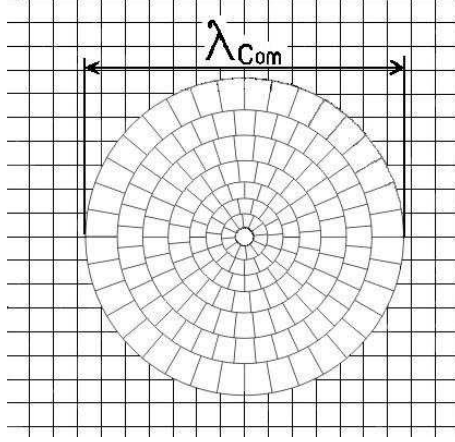


Figure 3: Particle as a local deformation of the tessellattice (the central cell) and the deformation coat that screens the particle from the degenerate tessellattice.

The degeneration of a cell is removed when the cell receives several deformations, such that its volume may be reduced, while the equivalent volume is redistributed among other cells. This means that in terms of conventional physics the deformed superparticle becomes a massive particle. The mass  $m$  of this particle is the product of a constant ( $C$ ) for dimension assessment by ratio of the volume ( $V$ ) of a superparticle to that of our reduced superparticle (which is already the particle),

$$m = C V_{\text{super}} / V_{\text{part}}. \quad (3)$$

By analogy with the deformation of a crystal lattice in the surrounding of a foreign particle, we have to recognize that a deformation coat appears around the particle, Figure 3. The radius of this coat is associated with the Compton wavelength  $\lambda_{\text{Com}}$  of the particle.

So, having the particle one may try to construct its mechanics in the tessellation space, which immediately will mean the development of physical laws and physics in general. Since the space should be densely packed with balls, any motion of a chosen (deformed) ball should be expressed in terms of interaction with other balls of the space. This brings about a radically new approach to the behavior of matter.

## 6. The submicroscopic mechanics

The submicroscopic mechanics of particles has been developed by the author in a series of works (see, e.g. Krasnoholovets, 2002a). When a particle starts to move, it undergoes “friction” on the side of the tessellattice and hence a packet of deformations goes forward the particle. These elementary excitations that migrate from cell to cell of the tessellattice in fact represent a resistance of

the space tessell-lattice, i.e. inertia, and, because of that, they have been called *inertons*. Thus, collision-like phenomena are produced: deformations (inertons) go from the particle to the surrounding space and then due to elastic properties of the tessell-lattice some come back to the particle. Such kind of the motion can be described by the appropriate Lagrangian that can be written as follows (simplified here)

$$L = \frac{1}{2}m\dot{x}^2 + \frac{1}{2}\mu\dot{\chi}^2 - \sqrt{m\mu}\dot{x}\chi/T \quad (4)$$

where  $m$ ,  $x$  and  $\mu$ ,  $\chi$  are the mass and the position of the particle and its inerton cloud, respectively;  $1/T$  is the frequency of collisions between the particle and the cloud.

The Euler-Lagrange equations show the periodicity in the behavior of the particle. Namely, the particle velocity oscillates between the initial value  $v$  and zero along each section  $\lambda$  of the particle path. This spatial amplitude is determined as follows:  $\lambda = vT$ . The same occurs for the cloud of inertons:  $\Lambda = cT$ . So, these two amplitudes become connected by means of the relationship  $\Lambda = \lambda c/v$ .

Furthermore, the solutions to the equations of motion show that the motion of particle in the tessell-lattice is characterized by the two de Broglie's relationships for the particle:  $E = h\nu$  and  $\lambda = h/(mv)$  where  $\nu = 1/(2T)$ . However, having these relationships we can readily derive the Schrödinger equation. This means that at this stage the submicroscopic mechanics passes into conventional quantum mechanics.

The amplitude of spatial oscillations of the particle ( $\lambda$ ) appears in quantum mechanics as the de Broglie wavelength. The amplitude of the particle's cloud of inertons ( $\Lambda$ ) becomes implicitly apparent through the availability of the wave  $\psi$ -function. Therefore, the physical meaning of the  $\psi$ -function becomes complete clear: it describes the range of space around the particle perturbed by its inertons.

The next stage is that inertons transfer not only inertial, or quantum mechanical properties of particles, but also gravitational properties, because they transfer fragments of the deformation of space (i.e. mass) induced by the particle. The corresponding study (Krasnoholovets, 2002b) shows that availability of dynamic inertons allows the derivation of Newton's static gravitational law,  $1/r$ . This physical law emerges owing the fact that the behavior of the object's inertons obeys the spreading of a standing spherical wave that is specified by the dependency  $1/r$ .

## 7. Concluding remarks

Thus mysteries of quantum mechanics might have met here a description in the real space and the inertons have been experimentally detected in conditions predicted by the theory (see, e.g. Krasnoholovets, 2002a). The submicroscopic mechanics fully restores determinism. In addition, quite recently my colleagues

and I have launched the project entitled “The inerton astronomy” in the framework of which we have made a special laboratory facility able to measure inerton waves. At present, we could record inerton signals along the West-East line at  $\sim 20$  Hz, which was associated with proper rotation of the globe. From September to December, 2004, we could record a flow of inertons at frequencies 18 to 22 kHz, which came from the northern sky in a universal time interval from 3 p.m. to 5 p.m.

The concept of the tessellated lattice of space replaces such uncertain notions as a classical elastic aether and a physical vacuum. This deeper concept allows an uncovering of many inner details of the constitution and behavior of particles and physical fields, which still elude researchers.

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